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THE DISTRIBUTION AND PHYSICAL PROPERTIES OF CHERT GRAVEL IN PIKE COUNTY, ILLINOIS

James C. Cobb and Norman C. Hester

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THE DISTRIBUTION AND PHYSICAL PROPERTIES OF CHERT GRAVEL IN PIKE COUNTY, ILLINOIS

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ABSTRACT

The distribution and character of chert gravels in Pike County were studied to determine the potential of these gravels as a source of skid-resistant aggregate for highway surfacing. Chert in Pike County is concentrated as gravel or broken fragments in three different areas (referred to as terranes in this report) in response to different geologic conditions: 1) in the northwestern part of the county, generally above an elevation of 750 feet, it occurs as a basal conglomerate (Hadley Gravel Member) of the Cretaceous Baylis Formation; 2) west and southwest of the Illinoian glacial boundary on the interfluves of the tributary streams of the Mississippi River, it is residual material resulting from extensive weathering of Mississippian cherty limestones, and 3) in the valleys of the streams tributary to the Mississippi River, it is a stream gravel resulting from fluvial action from post-Kansan time to the present.

These deposits are characterized by cherts that have suffered different degrees of chemical and physical weathering. The effects of various degrees of leaching and attrition have been measured by a number of tests or measurements, including those for roundness, abrasion, soundness, water absorption, specific gravity, and major oxide composition.

Field mapping, drilling, and seismic investigations showed that the greatest concentrations of relatively clean chert occur as valley fill and stream gravel in the wider portions of McCraney, Hadley, Kiser, Horton, Dutch, Sixmile, Honey, and Bay Creeks. On the basis of physical and chemical properties, these concentrations, which are in the major valleys tributary to the Mississippi River, have the greatest potential as an aggregate resource.

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INTRODUCTION

Chert gravels from Pike County, Illinois, have been tested by the Illinois Division of Highways, Bureau of Materials and Physical Research, and found to have potential as a skid-resistant aggregate. Highway test strips utilizing Pike County chert gravels are exhibiting favorable results, and the gravels appear promising for use as aggregate in bituminous base surfacing at intersections, ramps, and other road sites where skid resistance is needed. In order to evaluate the chert gravels of Pike County as a construction aggregate resource, information about their distribution and their physical and chemical properties is needed. The principal objectives of this study were to delineate the areas of unconsolidated cherty deposits, describe the various chert types, and determine their physical and chemical properties.

The area studied includes all of Pike County, which is located in west-central Illinois between the Illinois and Mississippi Rivers, approximately 35 miles north of their confluence (fig. 1). Figure 2 illustrates the distribution of surficial materials of Pike County.

To provide subsurface control on the distribution and stratigraphy of the chert gravels, four holes were drilled with the Illinois State Geological Survey's Mobil B-30S drilling rig (fig. 2). In order to determine the bedrock configuration of the major stream valleys of western Pike County, thereby allowing an estimate of the valley filling, seismic refraction profiles were run across these valleys (fig. 2). The instrument employed was the Survey's Geospace Portable Refraction System—Model GT-2B, a 12-channel system. DuPont Nitramon S was used as the source of energy. Each seismic refraction profile was shot on both ends to insure accurate measurement of seismic velocities and dips on the bedrock surface.

Samples were collected from outcrops and from four drill holes. To collect representative outcrop samples of the chert material, the channel sampling method was employed on steep faces and a sampling technique which involved collecting from 1-meter-square areas was used in gently sloping areas. During drilling operations, samples were obtained by a split-spoon sampling device driven 2 feet down at each 5-foot interval.

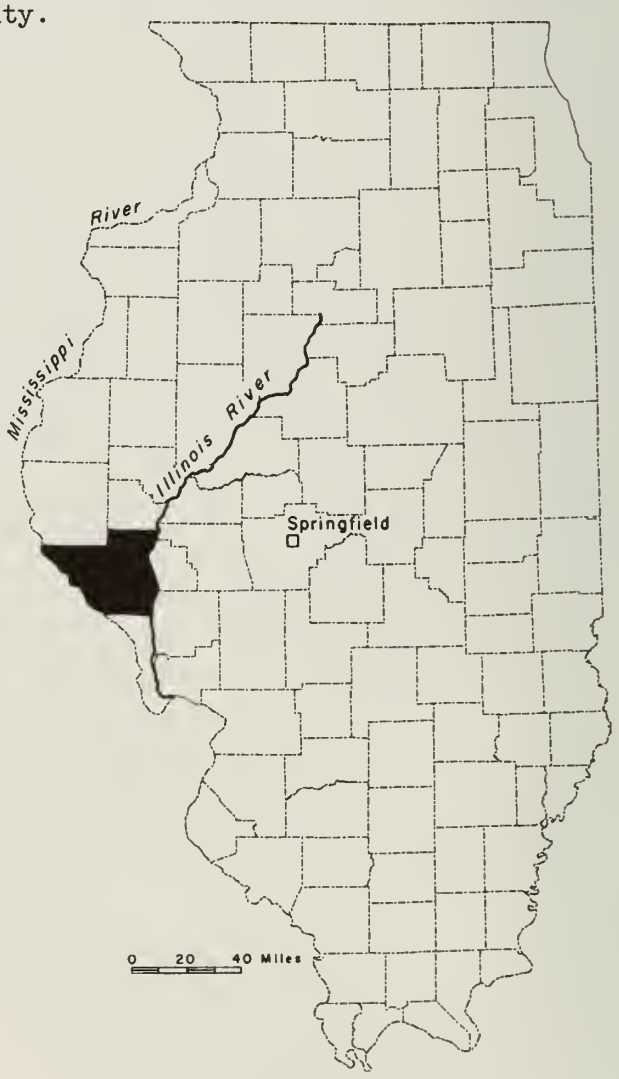

Fig. 1 - Location map of Pike County, Illinois.

Explanation for Fig. 2

A Mississippi River floodplain deposits: Thick deposits of silt and sand with limited quantities of chert; underlie a thick overburden of silt.

B Stream and terrace gravel deposits: Chert in stream gravel deposits and as valley fill in streams tributary to the Mississippi River. Thickness ranges from 10 feet to greater than 50 feet in the major tributaries. Overburden thickness averages about 15 feet.

The gravels are chert pebbles, white, gray, and brown; commonly are stained; have an earthy luster; subangular shapes predominate.

Pebbles from Hadley Gravel sources are most abundant toward the Cretaceous boundary. Erratics of quartz, quartzite, and igneous rock are not uncommon in stream gravels.

The chert has an average bulk specific gravity of 2.37 and an average water absorption of 3.2 percent.

C Illinoian glacial deposits: Deposits of glacial drift with only isolated deposits of chert-rich gravels.

D Kansan glacial deposits: Deposits of glacial drift highly weathered and thin or absent; however, underlying these deposits, residual and colluvial deposits of chert exist on the interfluves and slopes of valleys tributary to the Mississippi River (except where area is underlain by Pennsylvanian bedrock [F]). Thickness of chert ranges from near zero to 15 feet; typically dirty and has a cover of wind-blown silt.

The chert fragments are white with reddish stain, have an earthy luster, and frequently have a pocked surface.

The chert has an average bulk specific gravity of 2.2 and an average water absorption of 7.6 percent.

E Hadley Gravel deposits: Unconsolidated chert gravel occurring as the basal member of the Cretaceous Baylis Formation on the uplands in north-central Pike County. Thickness ranges from 5 to 15 feet and is usually less than 10 feet. Overburden thickness varies from near zero to more than 20 feet.

The gravels consist of pebbles which are predominantly red, brown, and gray chert. These are rounded and have a resinous luster. Quartzite pebbles are common.

The chert pebbles have an average bulk specific gravity of 2.5 and an average water absorption of 0.4 percent.

F Area underlain by Pennsylvanian rock.

G Deposits of residual and colluvial chert: same as those described in areas underlying Kansan glacial deposits.

Sand and gravel pit (active)

Sand and gravel pit (inactive)

Limestone quarry

6521 Surface sample number and location (see appendix)

3 ISGS test auger hole for this study

Illinois Division of Highways test auger hole

167-6 / 116' Seismic profile number, depth to bedrock, and orientation

Kansan glacial boundary

Illinoian glacial boundary

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The samples were subjected to various physical and chemical laboratory procedures. Measurements and tests for physical characteristics included those for roundness, abrasion, soundness, water absorption, and specific gravity. Chemical analyses to determine the major oxide composition of the cherts were made by X-ray fluorescence.

The Illinois Division of Highways, Bureau of Materials and Physical Research, performed the sodium sulfate soundness, specific gravity, water absorption, and Los Angeles abrasion tests. John A. Schleicher of the Analytical Chemistry Section of the Illinois State Geological Survey made the major oxide determinations. The seismic data were collected and interpreted by Paul C. Heigold of the Groundwater Section of the Survey.

ORIGIN OF DEPOSITS

Extensive deposits of water-laid chert gravel, Cretaceous and Pleistocene in age, occur in Pike County. Chert also occurs in this area as a residual concentrate developed on the uplands as a result of the weathering of Mississippian limestones. Figure 3, a generalized geologic column for Pike County, shows the bedrock units from which chert is derived by weathering and the stratigraphic positions at which chert gravels now occur. Because the distribution and character of the unconsolidated cherty deposits in Pike County are the results of processes that have taken place over a long period of time, a general understanding of the geologic history is desirable.

Following deposition of Mississippian and Pennsylvanian age marine shales, sandstones, and cherty limestones, a long interval of subaerial erosion was initiated, during which the cherty limestones (Keokuk-Burlington Limestone) were broken down through physical and chemical processes. The result was a residual accumulation of clay and chert fragments. No sediments are present in Pike County which represent that interval of geologic history (fig. 3) between Pennsylvanian (Carbondale Formation) and Upper Cretaceous (Baylis Formation) sediments. According to Frye, Willman, and Glass (1964), the pre-Cretaceous surface was relatively flat and featureless and the Baylis sediments were laid down as a sheet-like deposit in the littoral zone of a low-gradient coastal area. The basal gravels of the Baylis Formation are called the Hadley Gravel Member.

Following the deposition of the Cretaceous sediments, more subaerial erosion took place and stream dissection was so complete that the Cretaceous sediments are preserved only on the higher portion of the upland. Drilling samples recovered from a depth of 32 feet in Kiser Creek near its mouth have been identified as Kansan till (H. D. Glass, personal communication, 1972); therefore, most of this dissection had been accomplished prior to Kansan glaciation.

During the Pleistocene Epoch, a variety of sediments including gravel, sand, silt, clay, and till were deposited on the uplands and in tributary valleys of the Mississippi River. Kansan ice advanced from the west and covered one-half of Pike County. The Kansan glacial drift (Frye, Willman, and Glass, 1964) is weathered and occurs only in thin, patchy deposits. Glacial ice of Illinoian age spread into eastern Pike County from the north and northeast; however, outwash from this ice advance was not carried into the valleys such as those of Hadley, Kiser, or Dutch Creeks. The chert gravels that occur in streams and terraces of both Pleistocene and Holocene age contain few igneous, metamorphic, or carbonate pebbles derived from the glacial drifts.

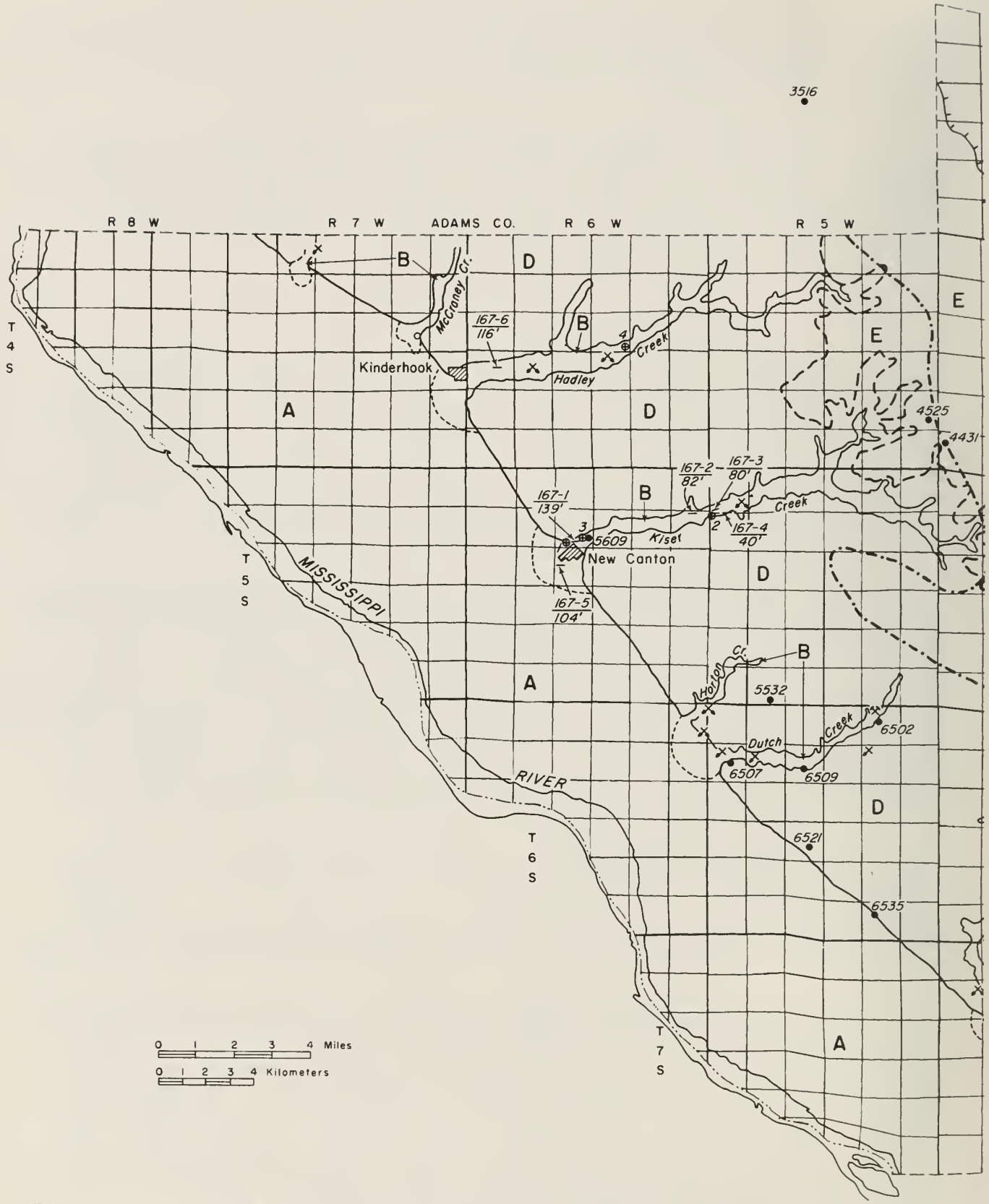
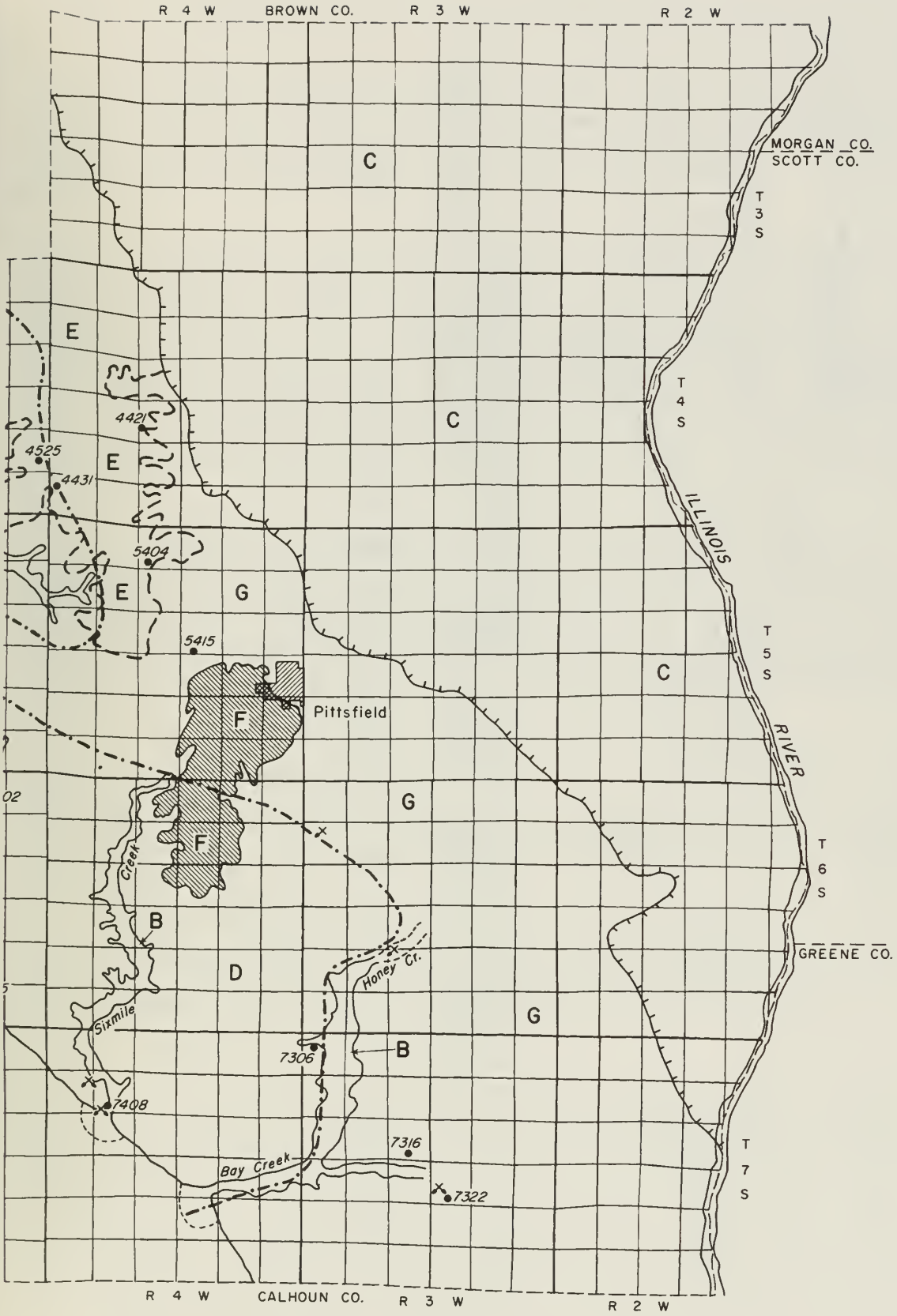


Fig. 2 - Surficial materials of Pike County, Illinois. Explanation is on page 3. (Pennsylvanian boundary from Reinertsen, 1964; Kansan and Illinoian boundaries from Willman and others, 1967.)


R 4 W
BROWN CO.
R 3 W
R 2 W
MORGAN CO.
SCOTT CO.
T 3 S
T 4 S
T 5 S
T 6 S
T 7 S
ILLINOIS RIVER
GREENE CO.
CALHOUN CO.
Pittsfield
Honey Cr.
Sixmile Creek
Bay Creek
4421
4525
4431
5404
5415
7306
7408
7316
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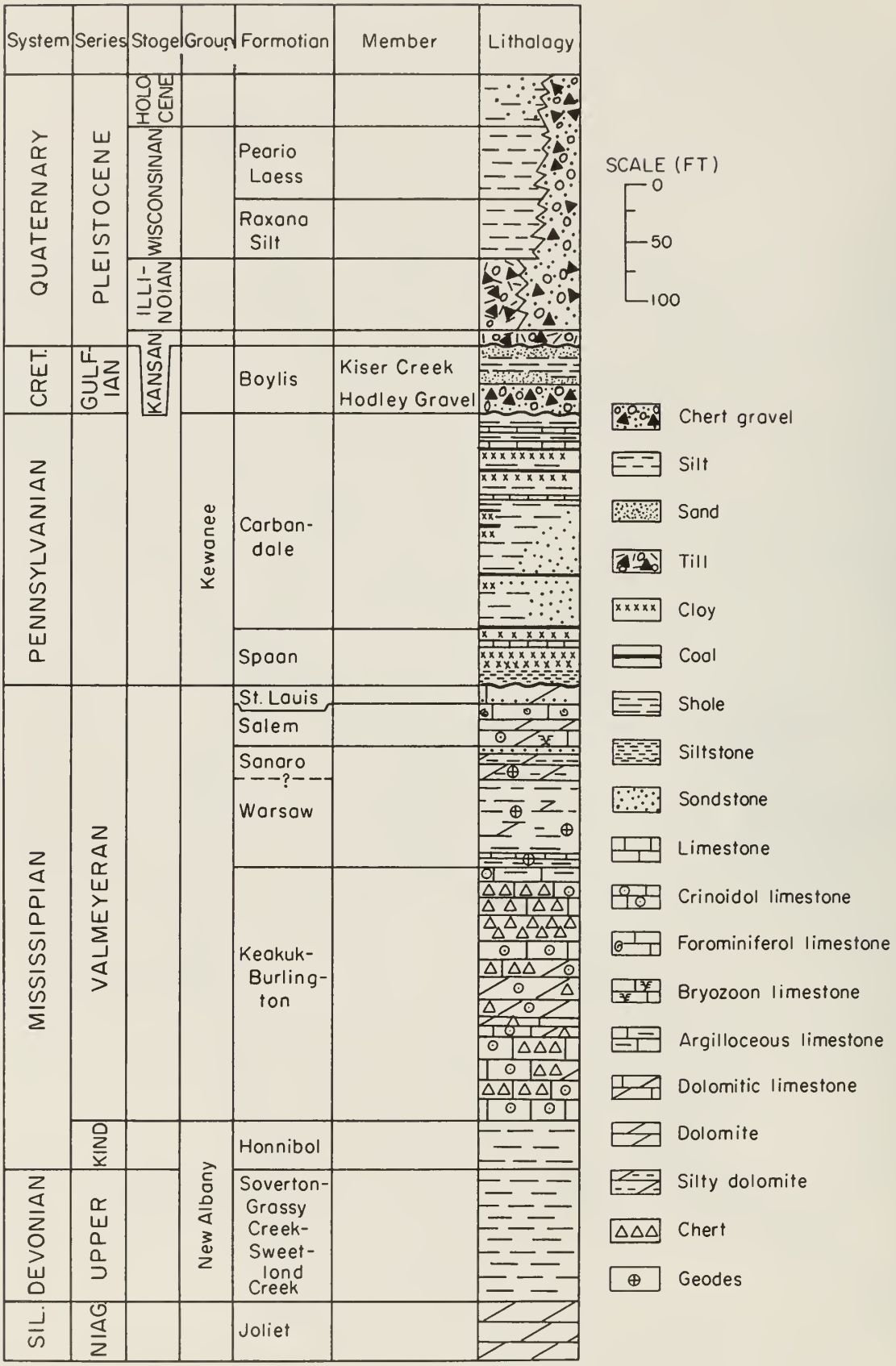


Fig. 3 - Stratigraphy of bedrock and surficial deposits in Pike County, Illinois (after Baxter, 1972).

TYPES AND DISTRIBUTION OF UNCONSOLIDATED CHERT DEPOSITS

The distribution of surficial materials in Pike County (fig. 2) is closely related to the geologic history of the area, and the various deposits occur within rather well defined geologic and physiographic boundaries. In figure 4, a generalized map is used to delineate five specific terranes whose surficial deposits have distinctly different origins.

Terranes I and II

Terrane I (fig. 4) is covered by Illinoian glacial drift consisting mainly of till with only isolated deposits of chert-rich gravels. Terrane II (fig. 4) includes the Mississippi River floodplain. This area has thick sand deposits underlying a thick overburden of silt and clay. Chert gravel is lacking in these floodplain deposits except where the major tributary streams have transported chert gravel out into the floodplain. These chert gravel deposits, existing at the mouths of Kiser, Hadley, and Dutch Creeks, also underlie a thick overburden of silt. Terranes III, IV, and V all contain chert material; these terranes are discussed in the following paragraphs.

Terrane III

Terrane III (fig. 4) includes the interfluves and slopes of tributary valleys; residual chert deposits, a mixture of clay and leached chert fragments, are found over a large area of this terrane, where they accumulated as a result of weathering of the underlying cherty limestones. The Keokuk-Burlington Limestone of Mississippian age (fig. 3) serves as the source for most of the residual material, and with the exception of small areas south of Pittsfield, this limestone underlies nearly all of terrane III (see fig. 4).

The residual chert is discontinuous, but an abundance of this chert is found on slopes and at the base of slopes as colluvial material. Where present, the residual material contains about 50 percent clay. In a limestone quarry in NW¼SE¼NW¼ sec. 2, T. 6 S., R. 5 W., the residual material was observed to have thicknesses ranging from near zero to greater than 10 feet and was overlain by loess.

The chert fragments are very angular and have conchoidal fracture surfaces. They commonly display an earthy luster and frequently a pocked surface. Their color varies from white with reddish stain to white with dark gray or black stain. Some of these fragments are fossiliferous.

Terrane IV

The Hadley Gravel, a chert gravel deposit, is the basal member of the Cretaceous Baylis Formation (fig. 3). The Baylis Formation is a surficial deposit occurring on the highlands of north-central Pike County. The area is designated as terrane IV (fig. 4). The chert gravel consists predominantly of yellow-brown to rusty brown chert that displays smooth well-rounded surfaces with a resinous luster. Other pebbles consist of white, purple, pink, gray, or yellow quartzite, and black, gray, or red chert. According to Frye, Willman, and Glass (1964), this sand and gravel was not locally derived, as only a few pebbles of what can be considered local chert contribute to the deposit; rather,

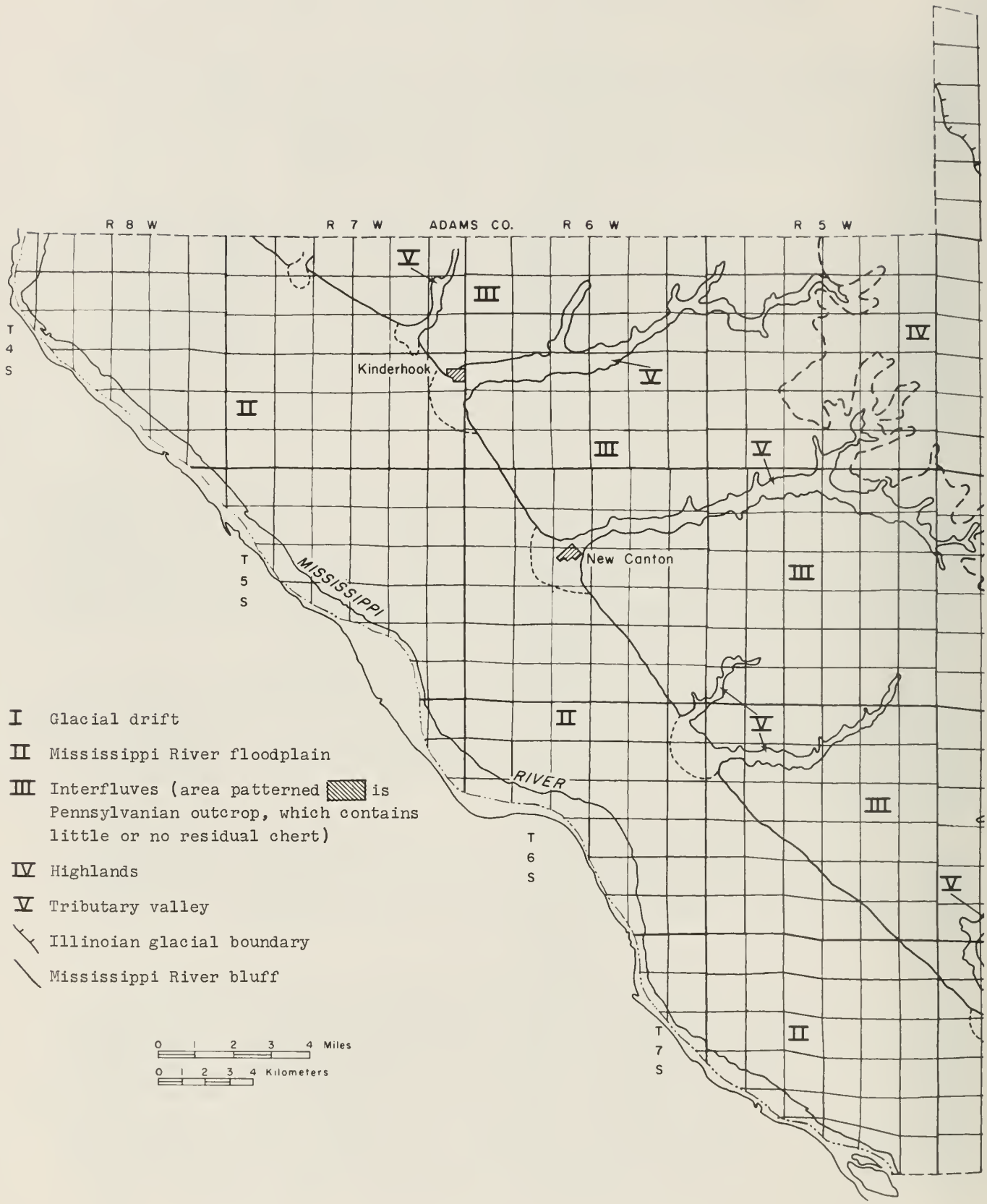
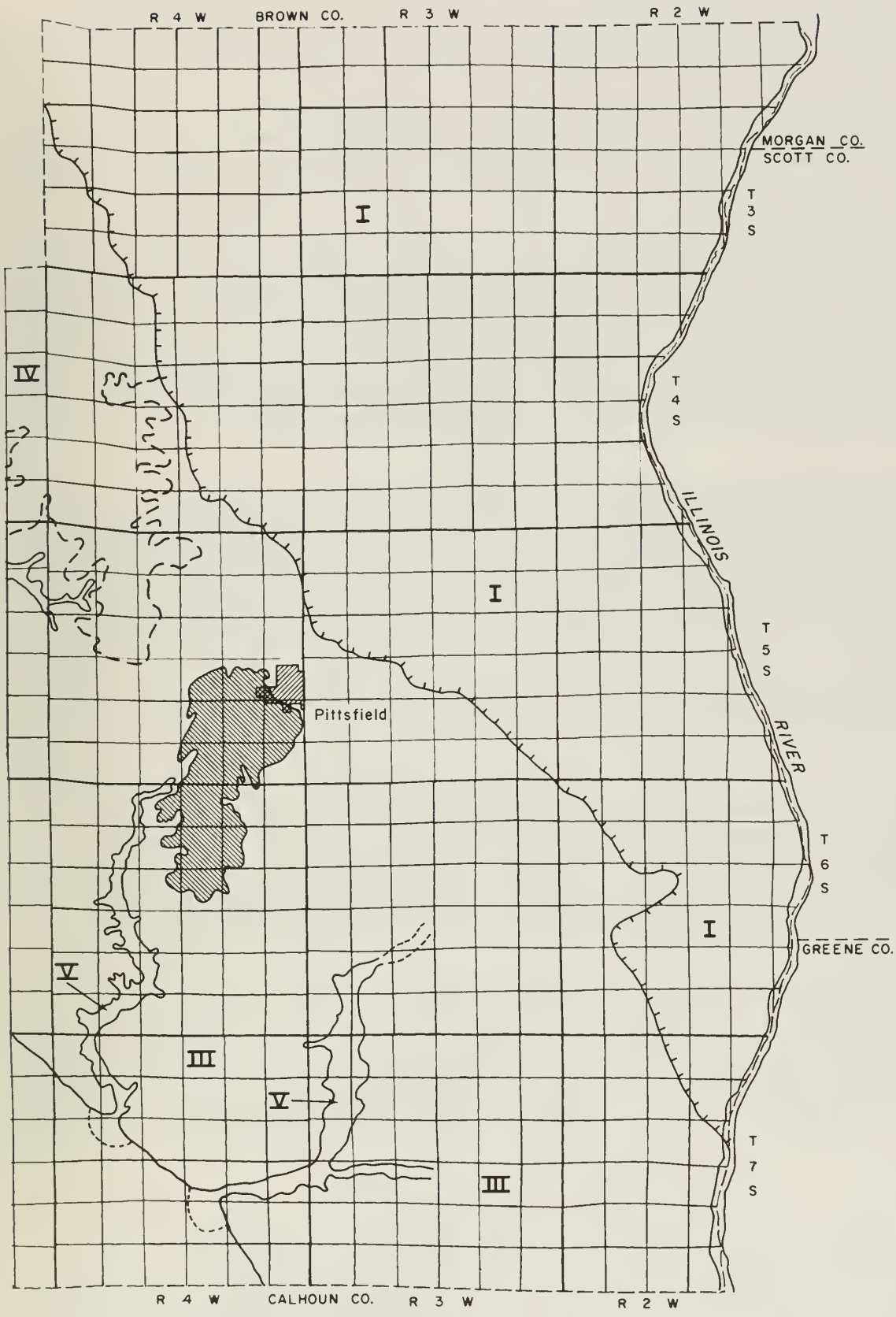


Fig. 4 - Generalized terranes



of Pike County, Illinois.

streams flowing from the north deposited the Hadley Gravel along an ancient shoreline. This deposit is discontinuous and exists in outcrop from nearly zero thickness to a maximum of less than 10 feet.

In the outcrops of the Hadley Gravel sampled for this study, the gravel was generally less than 5 feet thick. The Baylis Formation occurs on the uplands and generally follows the 750-foot contour (Frye, Willman, and Glass, 1964). However, local differences in the occurrence of Hadley Gravel do exist. During field work for this study, for example, the Hadley Gravel was found at an elevation of approximately 720 feet less than 1 mile east of El Dara, NE¼NE¼NE¼ sec. 21, T. 5 S., R. 5 W. Another exception is that Hadley Gravel occurs within the Illinoian glacial margin and is covered by glacial drift in areas extending from the eastern side of terrane IV into the southwestern quarter of T. 3, R. 4 and the northeastern quarter of T. 4, R. 4 in terrane I. The Hadley Gravel in general has an overburden of greater than 20 feet of sand and silt, and as much as 100 feet in the higher hills (see geologic section descriptions in Frye, Willman, and Glass, 1964).

Terrane V

Terrane V, which includes all of the major valleys tributary to the Mississippi River in Pike County, contains chert gravel both in the modern stream beds and terraces and as valley fill. Prominent terraces are present in all of the major tributary valleys, often at an elevation of around 540 feet. From limited exposures it appears that these terraces, particularly near the mouths of the tributary valleys, consist primarily of slack-water deposits of silt and clay. However, some of these terraces, for example, those along Dutch Creek, S½SE¼NE¼ sec. 7, T. 6 S., R. 5 W., consist of 3 to 4 feet of gravel at the base overlain by 15 feet of water-laid silt and fine sand, which is in turn overlain by 10 feet of loess.

In the lower reaches of the streams, the primary source of the chert is the local bedrock (Keokuk-Burlington Limestone) and the gravel is similar lithologically to the residual chert. The roundness of the gravel generally ranges from angular to subrounded. Many of the pebbles display conchoidal fracture surfaces. Colors range from light brown to white. Near the headwaters of the tributary streams, well-rounded brown gravels mixed with the more angular material reflect the contribution from the Hadley Gravel eroded from the uplands.

Stream gravel has been used extensively in secondary county road building and repairs in Pike County. Although there is a large number of active pits in Pike County (fig. 2), only one is currently operating with permanent equipment—the Missouri Sand and Gravel Company, 4 miles east of Kinderhook, NW¼NE¼NW¼ sec. 22, T. 4 S., R. 6 W. The chert gravel in this pit is reported to be as great as 20 feet in thickness. A list of gravel pit operators and locations is available at the Illinois Division of Highways Office, District 6, Springfield, Illinois.

Surface investigation proved the presence of chert gravel from the mouths of the major tributary valleys to near the heads (fig. 2). A drilling and seismic program was undertaken to develop data on the thickness of these deposits. As the tributary valleys have similar shapes, flow the same directions, and have much the same source of materials, our study was confined to two valleys, those of Kiser and Hadley Creeks, and the data acquired were extrapolated to other valleys for predicting the distribution of deposits. The locations of drill holes and seismic profiles are shown on figure 2.

Seismic data show that both Kiser and Hadley Creeks have a thick valley fill. Seismic profile 167-1, from near the mouth of Kiser Creek, indicates that bedrock occurs at a depth of approximately 140 feet. Profile 167-2, about 3 miles upstream from 167-1, shows a depth to bedrock of approximately 83 feet. Comparable thicknesses of unconsolidated deposits are indicated for Hadley Creek. As types of fill cannot be distinguished by the seismic technique, samples of the subsurface materials were obtained by drilling with the Illinois Geological Survey's Mobil B-30S drill.

In the valley of Kiser Creek, just northeast of New Canton in NE¼SE¼SE¼ sec. 9, T. 5 S., R. 6 W., hole 3 was drilled and split-spoon samples were taken at 2½-foot intervals. According to the seismic data, the valley of Kiser Creek here is deeper than 100 feet; however, only 13 feet of chert gravel was encountered in the 35 feet drilled. The gravel was found underlying 14 feet of silt and overlying calcareous till that was identified as Kansan in age. Hole 2, drilled in the bed of Kiser Creek, NW¼NW¼NW¼ sec. 7, T. 5 S., R. 5 W., about 3½ miles upstream from hole 3, penetrated at the surface 16 feet of clean, coarse chert gravel overlying bedrock.

A seismic profile, 167-6, in Hadley Creek approximately 1 mile east of Kinderhook, shows a depth to bedrock of 116 feet (fig. 2). Hole number 4, drilled with solid-stem augers in the valley of Hadley Creek in the SE¼SE¼SE¼ sec. 15, T. 4 S., R. 6 W., about 3 miles upstream from profile 167-6, penetrated 55 feet of chert gravel underlying about 15 feet of silt and sand. The hole was bottomed in chert gravel, and bedrock was not reached in the 70 feet penetrated.

A hole drilled by the Illinois Division of Highways, District 6, where U.S. Highway 36 crosses McCraney Creek approximately 1 mile northwest of Kinderhook, penetrated 56 feet of sand and chert gravel underlying 20 feet of silty overburden. Bedrock was not encountered.

In summary, drilling information indicates that chert gravel throughout the major valleys in Pike County ranges in thickness from 14 feet to more than 50 feet and rests on bedrock, silt deposits, or Kansan till. Thickness of overburden on the gravel ranges from zero in stream beds to as much as 15 feet of silty clay and silty sand (hole no. 4, SE¼SE¼SE¼ sec. 15, T. 4 S., R. 6 W.) in the floodplains. The wide variations in chert gravel thickness and a lack of direct correlation between gravel thickness and thickness of valley fill are due in part to the silting up of these valleys during high water levels of the Mississippi River and subsequent channeling of these silt deposits before the streams carried gravel into the valleys. Where Kansan till is present in the bottom of these valleys, the irregular thickness of gravel fill also suggests that the chert gravel was deposited on an irregular surface developed by stream erosion of the Kansan till.

PHYSICAL AND CHEMICAL PROPERTIES

A program of testing and analysis of the Pike County chert gravels was devised in order to determine the physical and chemical characteristics of the chert and the suitability of the various chert deposits for use as aggregate. Samples of essentially unweathered chert from outcrops of Mississippian limestone were included in the testing to serve as a point of reference for changes

in the chert due to weathering. Measurements to determine roundness, water absorption, and bulk specific gravity, and tests to determine the abrasion, soundness, and major oxide composition were made. Table 1 lists the results of the physical tests and measurements. Table 2 lists the results of major oxide analyses.

Physical Tests and Analyses

Roundness

Roundness measurements of samples of the various types of chert were made according to Krumbein's visual roundness classification (Krumbein, 1941). The bar graph in figure 5 shows that the roundness of pebbles from the Hadley Gravel is greater than that of pebbles from other chert deposits. The residual chert is angular, reflecting the lack of stream action during its geologic history. Stream and terrace gravels are rounded but to a lesser extent than the Hadley Gravel, demonstrating less stream abrasion than that experienced by the Hadley Gravel.

Abrasion

The abrasion of the chert gravel was evaluated by means of the Los Angeles test (American Society for Testing and Materials, 1972, ASTM C 131 - 69, p. 84-87). This test shows the relative resistance of materials to mechanical

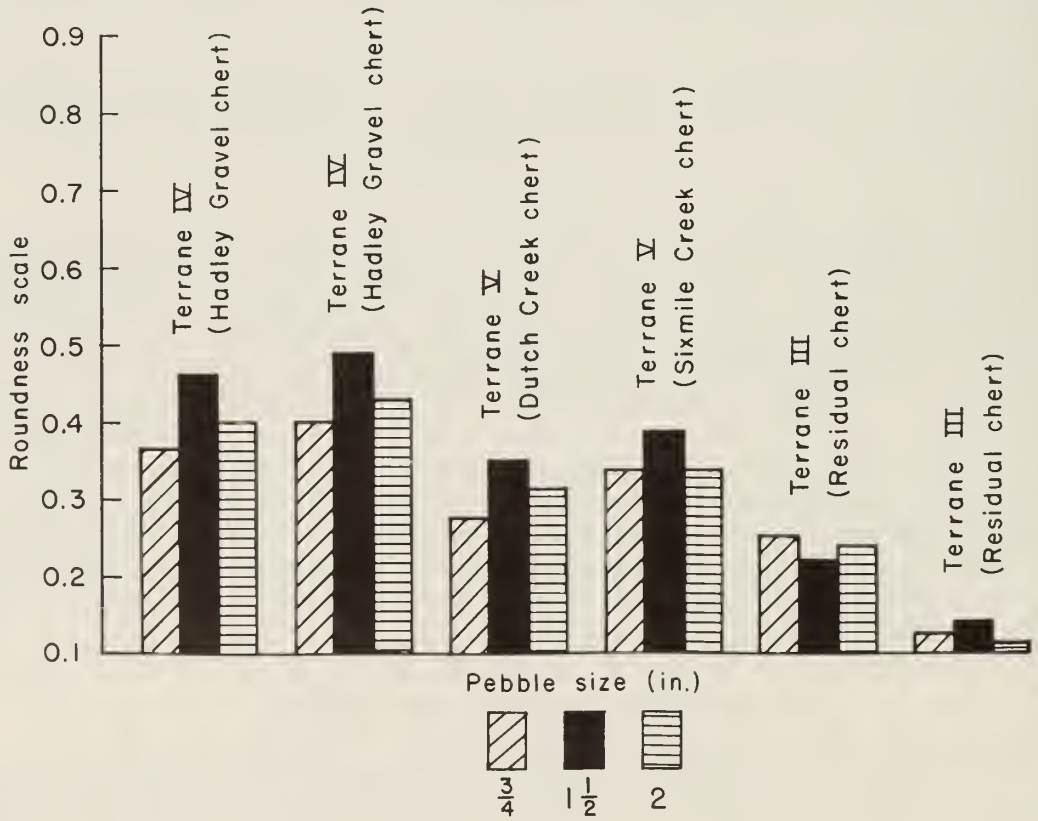


Fig. 5 - Comparison of pebble roundness of chert from terranes III, IV, and V.

TABLE 1 — RESULTS OF PHYSICAL TESTS ON PIKE COUNTY CHERT MATERIAL[a]

Sample number[b]	Type of deposit	Terrane (fig. 3)	Abrasion[c] (% wt. loss)	Soundness[d] (% wt. loss)	Water absorption[e] (% wt. gain)	Bulk specific gravity[e]
4421	Hadley Gravel	IV	19.7	0.13	0.30	2.60
4431	Hadley Gravel	IV	21.5	0.22	0.50	2.58
4525	Hadley Gravel	IV	18.3	1.01	0.40	2.57
5404	Hadley Gravel	IV	22.3	1.47	0.40	2.59
5415	Residual	III	29.5	12.49	4.30	2.30
5532	Residual	III	28.7	20.13	8.10	2.16
6502	Residual	III	25.0	24.31	9.30	2.04
6507	Stream	V	20.0	8.03	3.30	2.35
6509	Stream	V	21.8	4.61	2.40	2.44
6535	Stream	V	22.9	8.35	3.50	2.33
7306	Stream	V	20.7	7.36	4.01	2.35
7408	Stream	V	22.1	4.49	4.00	2.40
7316	Bedrock chert	III	21.6	15.00	9.12	2.25

[a] Testing by Bureau of Materials and Physical Research, Illinois Division of Highways, Springfield, Illinois.
[b] See sample ledger (appendix) for locations.
[c] Test by Los Angeles machine (ASTM C 131-69).
[d] Test by use of sodium sulfate (ASTM C 88-71a).
[e] ASTM test C 127-68.

abrasion. Results of this test (table 1, fig. 6) indicate that the Hadley Gravel is most resistant to abrasion. The percent of weight loss from abrasion during testing of the Hadley Gravel chert ranged from 18.3 to 22.3 percent. Stream and terrace chert gravels showed a percentage loss ranging from 20.0 to 22.9 percent. Residual chert exhibited the greatest percent loss, ranging from 25.0 to 29.5 percent. A sample of bedrock chert from local Pike County limestone (Keokuk-Burlington Limestone) had a loss of 21.6 percent.

Soundness

Soundness was evaluated by the sodium sulfate test (American Society for Testing and Materials, 1972, ASTM C 88 - 71a), which gives an assessment of the durability of an aggregate under freeze-thaw weathering conditions. Evaluation of the soundness of chert material is made in terms of a percentage loss in weight determined by resistance to disintegration of sized aggregate samples, alternately saturated in sodium sulfate (Na_2SO_4)-water solution and oven dried. A high percentage loss is indicative of poor durability during freezing and thawing; conversely, a low value indicates good durability.

Figure 7 shows the soundness test results of samples of the various types of chert material encountered in Pike County. The Hadley Gravel samples exhibited the lowest percentage loss, ranging from 0.13 to 1.40 percent. The stream and terrace gravels have a loss ranging from 4.61 to 8.35 percent.

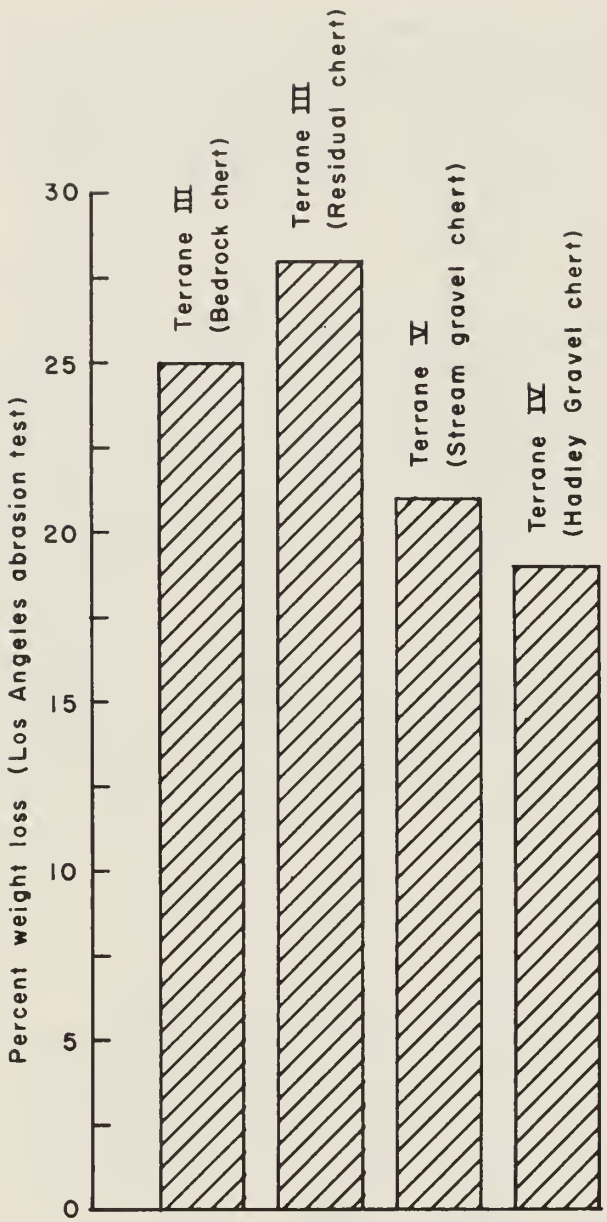


Fig. 6 - Comparison of results of Los Angeles abrasion tests on chert from terranes III, IV, and V.

Residual chert exhibits the poorest durability, ranging from 12.49 to 24.31 percent loss. A sample of local bedrock chert had a loss of 15.00 percent.

Water Absorption and Specific Gravity

Bulk specific gravity is a measurement indicating the ratio of the volume of pore space to volume of solid. Water absorption is measured by the amount of water that can enter

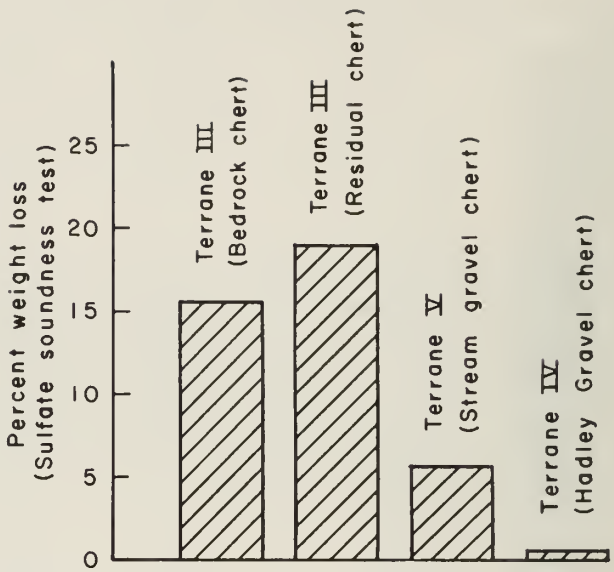


Fig. 7 - Comparison of results of sulfate soundness tests on chert from terranes III, IV, and V.

pore spaces. The results of the specific gravity and water absorption measurements are included in table 1. These data show that the Hadley Gravel samples have the highest specific gravity and also the lowest amount of water absorption. The stream and terrace gravels have lower specific gravities than the Hadley Gravel samples but higher than those of the residual chert. The measurements of water absorption for the stream and terrace gravels are intermediate between those for the Hadley Gravel samples and the residual chert material.

The residual chert material exhibits the lowest specific gravity and the highest amount of water absorption, indicating more pore space than in the other types of chert.

Chemical Tests and Analyses

X-ray fluorescence was used to analyze the various types of chert for their major oxide composition. The samples used were mechanical splits of channel and other samples collected in the field. The material from the final split of the field samples was ground to less than 230 mesh, and the samples used for chemical analysis were split from the powdered material. The elements analyzed include Si, Fe, Ca, Al, Mn, Mg, K, C, and Ti. Table 2 lists the various elements in terms of their oxides and shows the average weight percent of each.

The chert materials analyzed for this study average about 96 percent SiO_2 by volume. Al_2O_3 and Fe_2O_3 make up about 1.5 and 0.5 percent, respectively. The other oxides make up smaller amounts, as shown by individual samples in table 2.

TABLE 2 — MAJOR OXIDES OF PIKE COUNTY CHERT MATERIAL*

Sample number†	Type of deposit	Terrane (fig. 3)	Weight percent of major oxides								
			SiO_2	TiO_2‡	Al_2O_3	Fe_2O_3	MnO	MgO‡	CaO‡	K_2O‡	CO_2‡
3516*	Hadley Gravel	IV	96.7	-	2.43	0.75	.020	-	0.01	-	-
4431	Hadley Gravel	IV	95.8	-	2.83	0.92	.035	-	0.02	-	-
5415	Residual	III	96.1	0.04	2.43	0.95	.017	-	0.04	-	-
7322	Residual	III	97.7	-	1.35	0.54	.018	-	-	0.01	-
6509	Stream	V	96.5	-	2.09	0.93	.025	-	0.03	-	-
6535	Stream	V	97.3	-	1.06	1.18	.020	-	0.01	-	-
7306	Stream	V	97.4	-	0.62	1.48	.029	-	-	-	-
7316	Bedrock chert	III	96.6	-	0.13	0.13	.022	-	1.68	-	1.28

* Sample 3516 taken from Adams County.

† For sample locations, see figure 2.

‡ Datum designated by dash (-) indicates "not detected, less than 0.01%."

SUMMARY

Three terranes in Pike County (fig. 4) contain major amounts of unconsolidated chert materials. These are terrane III (residual chert rubble), terrane IV (Cretaceous Hadley Gravel), and terrane V (Pleistocene stream and terrace gravel). These terranes are defined on the basis of geologic and physiographic boundaries. The Hadley Gravel occurs in relatively thin, discontinuous sheet deposits on the highlands and in the stream beds of the north-central part of the county, generally above an elevation of 750 feet (terrane IV). Residual chert and colluvial chert are found as a product of limestone weathering on the interfluves and slopes of the tributary valleys of the Mississippi River (terrane III). Where residual chert developed elsewhere in the county, it was subsequently buried by Illinoian drift (terrane I). Residual concentrations of chert are locally discontinuous and occur in relatively thin weathering profiles with an abundance of clay. In the many places where the clay matrix has been removed, residual chert accumulates at the base of steep slopes as a clean colluvial deposit. The Pleistocene stream gravels (terrane V) are found both as deposits buried in the alluvium of valleys tributary to the Mississippi River and as terrace deposits in the modern streams tributary to the Mississippi

River. These types of chert deposits are heterogeneous, containing a predominance of locally derived chert in the lower reaches of the streams near the Mississippi floodplain; however, toward the highlands pebbles of the Hadley Gravel are also found.

Table 3 shows a summary of the results of physical and chemical analyses of samples of Hadley Gravel (terrane IV), stream and terrace chert gravel (terrane V), and residual chert (terrane III). Also included are results of the analyses of locally derived bedrock chert to serve as a comparison to the weathered varieties. The Hadley Gravel chert demonstrates the lowest loss in destruction testing (Los Angeles abrasion and sulfate soundness) and the least water absorption. The Hadley Gravel chert has a significantly higher specific gravity than the other common Pike County chert materials. Stream and terrace chert showed somewhat greater losses in the destruction tests and more water absorption than the Hadley material. The specific gravity of stream and terrace chert material is lower than that of the Hadley Gravel chert. Residual and colluvial chert material exhibits the highest loss in destruction testing, a significantly greater amount of water absorption, and the lowest specific gravity.

TABLE 3 — SUMMARY OF SIGNIFICANT RESULTS OF CHEMICAL AND PHYSICAL ANALYSES
(Values are averages of results of analyses of deposits sampled.)

Deposits Sampled	Terrane	Roundness index	Abrasion (percent wt. loss)	Soundness (percent wt. loss)	Water absorption (percent wt. gain)	Bulk specific gravity	SiO_2 (weight percent)	Al_2O_3 (weight percent)	Fe_2O_3 (weight percent)
Hadley Gravel chert	IV	Rounded	19.0	0.7	0.4	2.58	96.3*	2.63*	0.83*
Stream and terrace chert gravel	V	Subangular	21.0	5.8	3.2	2.37	97.0	1.25	1.19
Residual and colluvial chert	III	Angular	28.0	19.0	7.6	2.16	96.9	1.89	0.74
Bedrock chert	III	Not applicable	25.0	15.5	4.0	2.25	96.6	0.13	0.13

* Includes sample 3516 from Adams County.

The chemical data show oxide compositions by weight percent for the chert materials of Pike County. SiO_2 makes up at least 96 percent of all the chert samples.

The Al_2O_3 content is highest in the Hadley Gravel (2.63), followed by that in residual chert (1.89), stream chert gravel (1.25), and bedrock chert (0.13).

The Fe_2O_3 content is greatest in the stream and terrace chert gravel (1.19) followed by that in Hadley Gravel chert (0.83), residual chert (0.74), and bedrock chert (0.13).

The residual chert deposits in terrane III, because of their poor physical characteristics (table 3), their occurrence with an abundance of clay matrix, and their discontinuous nature, are eliminated as a potential aggregate resource. Colluvial chert deposits, which occur at the base of slopes, can also be considered a poor potential aggregate resource.

Hadley Gravel (terrane IV), because of its limited distribution and thickness, is of doubtful value as an aggregate resource at this time. Although its physical characteristics demonstrate its sound nature, the availability of Hadley Gravel is not sufficient to characterize it as a potential aggregate resource.

The stream and terrace gravels (terrane V), which occur in relatively large quantities in valleys tributary to the Mississippi River, have physical properties that demonstrate a relatively sound nature. Therefore, the stream and terrace gravels have the greatest potential as a source of chert aggregate.

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APPENDIX - Sample Ledger

Sample No.* T.-R.-Sec.	Location ¼ ¼ ¼	Terrane	Comment	Analyses Completed
3516†	NW NW SE	IV	Outcrop of Hadley Gravel Member, Baylis Formation	Major oxide composition only.
4421	SW NW NW	IV	Outcrop of Hadley Gravel Member, Baylis Formation	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity.
4431	NW SW SE	IV	Aberdeen School Section, Hadley Gravel Member	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity, and major oxide composition.
4525	NE SW NW	IV	Outcrop of Hadley Gravel Member, Baylis Formation	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity.
5404	SE SW SW	IV	Outcrop of Hadley Gravel Member, Baylis Formation	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity.
5415	SW SE SW	III	Upland residual rubble from roadcut	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity, and major oxide composition.
5532	SE SW SE	III	Residual chert rubble as quarry overburden	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity.
5609	NE SE SE	V	Kiser Creek terrace gravel	Roundness only.
6502	SW SE SE	III	Residual chert rubble as quarry overburden	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity.
6507	SW SE NE	V	Dutch Creek terrace gravel	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity.
6509	NW NW SE	V	Dutch Creek stream gravel	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity, and major oxide composition.
6521	SE NW SE	V	Ambrosia Creek stream gravel	Roundness only.
6535	NE SE NW	V	Two Mile Creek terrace gravel	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity, and major oxide composition.
6601	NE SW SE	V	Horton Creek terrace gravel at site of active gravel pit	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity.
7306	SW NE NW	V	Cold Run Creek stream gravel	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity, and major oxide composition.
7316	NE SE SW	III	In situ chert material from limestone bedrock	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity, and major oxide composition.
7322	NE SE SW	III	Residual chert rubble above limestone bedrock	Roundness and major oxide composition.
7408	NW SE SW	V	Sixmile Creek stream gravel	Roundness, Los Angeles abrasion, sodium sulfate soundness, water absorption, bulk specific gravity.

* Sample numbers contain the township, range, and section number of each sample locality. The first number refers to township, the second refers to range, and the last two indicate the section. All townships are south of the base line, and all ranges are east of the principal meridian.

† Sample 3516 taken in Adams County.

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